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Determinants of Clinical Information Logistics: Tracing Socio-Organisational Factors and Country Differences from the Perspective of Clinical Directors

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Abstract. The establishment of successful clinical information logistics (CIL) within the care processes is one of the main objectives of strategic health IT management in hospitals. While technical realisations in terms of useful, usable and interoperable IT solutions are essential precursors of CIL, there is limited empirical research on what socio-organisational factors underlie an innovation-friendly culture and how they can affect successful information provision. We applied factor analysis on survey data from 403 clinical directors from Germany, Austria and Switzerland and used the dimensions identified to explain the level of CIL with ordered logistic regression analysis. The intensity of collaboration and exchange with the IT department as well as the degree of executive IT leadership showed to be strongly associated with better CIL while personal views and attitudes of clinical directors were not. Analysing country differences revealed the degree of the exchange with the IT department to be significantly lower in German hospitals. This points at a potential strategic lever for German hospital executives to focus on.

Keywords. Organisational culture, diffusion of innovation, clinical information logistics

1. Introduction

Due to their role as executive managers of the hospital's clinical staff, medical and nursing directors play a crucial role in strategically coordinating care processes – a responsibility that increasingly involves the integration of health information technology (HIT) to generate information at the point of care and to weave it into the care processes [1]. The goal of workflow support through health information technology (HIT) can be tied to the concept of clinical information logistics (CIL), i.e. the principle aiming to provide the right information for the right person, at the right time and in the right quality, making it an important precursor of safe and high quality care [2, 3]. While it is known that adoption rates and IT-quality can substantially differ across organisations [4] and countries [5], we are interested in what generalisable socio-organisational factors are

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associated with higher levels of CIL. This knowledge will help deduce meaningful levers for strategic IT-management.

Establishing successful CIL is a multifaceted challenge. Building on previous results that point at the importance of an organisation's "innovative power" in the digitalisation of hospital care [6], our goal in this study was to look beyond technical realisations and structural hospital characteristics and focus on underlying aspects of an innovation-friendly culture that can drive better CIL. Herein, we did not only look at peculiarities inherent to the organisation itself but also aimed to better understand the role medical and nursing directors play. This included particularly their personal views and attitudes towards IT as they might be able to establish more successful information logistics within clinical workflows.

This research is part of the international initiative "IT Report Healthcare" that aims at measuring the state of digitalisation in secondary care and related topics across German, Austrian and Swiss hospitals in the context of international developments. Thus, we also aimed at gaining insights about differences in CIL and its socio-organisational covariates in Germany compared to Austria and Switzerland.

2. Method

Data analysis was based on a survey that aimed to assess the IT-usage, IT-workflow-support, IT-quality and the socio-organisational environment with regard to innovative HIT from the perspective of nursing and medical directors. Most items were based on existing surveys whereas some scales were newly developed and pretested in two iterations by a total of 14 experts (including executive health professionals, health IT scientists, statisticians, management researchers and one psychologist). The goal was to yield a comprehensive overview on these issues in German, Austrian and Swiss hospitals and therefore targeted medical and nursing directors of 2,421 hospitals. With regard to the socio-organisational environment, we focused on the "innovation capabilities" [7] of the respective respondents and their organisation by issuing a set of statements on related topics and asked for their (dis-)agreement on a 5-point-Likert scale (Tab. 1).

In order to assess socio-organisational determinants of CIL[2] we used a combined approach by applying an ordered logistic regression analysis on factor scores. Factor analysis was applied in order to investigate and extract underlying dimensions of the scale set. We used polychoric correlation coefficients in the correlation matrix together with unweighted least squares (ULS) estimation since all items were measured on ordinal scales (Tab. 1) [8]. Applicability of the correlation matrix was evaluated based on the Kaiser-Meyer-Olkin (KMO) criterion and Bartlett's test of sphericity. Factors were extracted if their eigenvalue exceeded 1, if all components explained at least 50% of the total variance and based on assessing the scree plot.

The factor scores obtained from the final factor solution were then used to predict the level of CIL using ordered logistic regression and controlling for hospital size, ownership (profit vs. non-profit), health system affiliation and the existence of a surgery room. These demographics are known to potentially influence IT adoption levels [9, 10] and therefore might also be influencing successful CIL. Data was tested for

[2] CIL was measured on a single ordinal scale, referring to the entirety of the organisation. Respondents were asked to indicate their (dis-)agreement with the statement "Our IT-system is always able to provide the right information, at the right time, at the right place and in the right quality within the clinical workflows".

multicolliniarity and proportional odds of the independent variables. For comparing country differences of the extracted factors and the perceived level of CIL in German vs. non-German hospitals we additionally performed t-tests on the factor scores and a Mann-Whitney-U-test on the level of CIL.

3. Results

We received completed responses from 403 out of a total of 2,421 hospitals contacted (response rate: 16.6%). 81.4% of responses came from Germany (response rate: 16.8%; n_{GER} = 328), 9.1% from Austria (response rate: 14.2%; n_{AUT} = 37), and 9.5% from Switzerland (response rate: 18.0%; n_{CH} = 38). Data from Austria and Switzerland were pooled and contrasted with those from Germany to obtain more balanced group sizes.

Table 1. Factors and factor loading matrix. Loadings below .25 are left blank (n = 403).

Item	Factor			
	1	2	3	4
Factor "Executive IT leadership"				
"Our executive board actively promotes the initiation of innovative IT projects."	-.89			
"Our hospital shows great agility/flexibility when it comes to implementing new IT solutions."	-.63			
"Our executive board regularly perceives IT as a mere expense factor."	.55			
"Our executive board explicitly demands ideas and suggestions on how to innovate our IT."	-.51			
"I have often received positive feedback for putting forward innovative ideas."	-.37			
Factor "Exchange with IT department"				
"Our IT department gives users a better understanding of the benefits of IT."		.87		
"Our IT is capable to react quickly in face of changing requirements."		.86		
"The CIO incorporates suggestions and works with us to develop appropriate solutions."		.77		
"If there are any questions about IT, I have a personal contact person in the IT department."		.54		
"The IT department does not really seem to be present in our hospital."		-.53		
"We openly communicate/discuss new IT projects in our hospital among all involved staff."		.49		
"In our hospital, IT is considered early on in most medical or nursing innovations."		.42		
Factor "Proactive behaviour"				
"I regularly talk to people from outside our hospital about new IT solutions for our hospital."			.76	
"I regularly take time to think about IT-based optimisations of our hospital operations."			.75	
"I actively call for new IT solutions to improve clinical processes."			.64	
"I regularly seek to discuss strategic IT issues with our CIO"			.55	
Factor "Health IT attitude"[3]				
"IT solutions are often incompatible with the norms and values of nursing and medical care."				.61
"Experience has shown that new IT projects tend to make things more difficult than easier."				.59
"IT undermines medical and nursing autonomy in patient care."				.56

The data set showed to be suitable for factor analysis with a KMO measure of .92 and according to Bartlett's test of sphericity with $p < .001$. We attained a final set of 20 items reflecting 4 factors that explain 62% of the total variance (Tab. 1). Reliability measure ranged from 0.62 to 0.87 indicating solid internal consistency (Tab. 2). The second factor "exchange with IT department" proved to be significantly higher in Austria and Switzerland compared to Germany whereas all other factor scores did not differ across

[3] The factor is inverted. Stronger agreement on these three items technically implies a worse attitude towards HIT since the statements are negatively worded. The same kind of inversion applies to the first factor.

countries (Tab. 2). Furthermore, the Mann-Whitney-U-test result indicated a significantly higher (p=.005) level of successful CIL in the non-German countries ($\bar{x}$ = 3.30 ± 1.10) compared to German hospitals ($\bar{x}$ = 2.77 ± 1.09).

Table 2. Reliability and factor score differences between German and non-German hospitals (n = 403).

Factor	Cronbach's α	$\bar{x}$ German	$\bar{x}$ non-German	SD (German)	SD (non-German)	p-value
(1) Executive IT leadership	.79	.04	-.12	.96	.84	.25
(2) Exchange IT department	.87	-.06	.34	.94	.83	.00
(3) Proactive behavior	.76	.05	.03	.87	.98	.86
(4) Health IT attitude	.62	.01	-.10	.79	.81	.31

Prediction of the level of CIL through ordered logistic regression demonstrate significant influences of "executive IT leadership" and "exchange IT with department". "Proactive behaviour" and "health IT attitude" did not affect CIL significantly. The model controls for potential demographic covariates (hospital size, ownership (profit vs. non-profit), health system affiliation and the existence of a surgery room), none of which were significantly associated with CIL. Overall, it explains about 44% of the variance in CIL (Cox and Snell pseudo R^2). Assumptions about the absence of multicollinearity and proportional odds are met according to VIF measures way below 4 for all predictors and a non-significant result of the test of parallel lines.

Table 3. Ordered logistic regression model (chi^2 = 202.8, df = 8, p<.001) with ** p<.001 for coefficient.

Independent Variables	Ordered Logit Coefficient
Executive IT leadership	-.66**
Exchange with IT department	1.30**
Proactive behaviour	.05
Health IT attitude	-.03

4. Discussion

Four consistent factors could be identified from statements of medical and nursing hospital directors in Austria, Germany and Switzerland: the degree to which the hospital executives promote and lead change towards innovative HIT-solutions, the degree of exchange and collaboration with the IT department, the personal proactive behaviour in IT matters and the personal attitude towards HIT. These factors fit well with comparable structures found in previous works focussing on the CIO's point of view [7]. Support and encouragement from the executive board as well as a collaborative and user-centred approach in IT management have also been pointed at as essential predictors for innovative HIT to prosper [10, 11]. Our study carried on these findings adding the strong association of these two factors with better clinical information logistics (CIL). However, on the personal level of the respondents, behavior and attitudes do not seem to alter CIL.

In accordance with lower adoption rates [5], the perceived level of CIL showed to be lower in German hospitals compared to Austria and Switzerland. When extending the view on factor differences, it is interesting to note that the collaboration with IT departments appears to be closer and more active in the non-German hospitals while the other factors did not differ across countries. This points at a potential deficit in strategic IT management in German hospitals and should be taken up in further research. The studies main limitation stems from modest response rates across countries that might

have caused a non-response bias. Results should therefore be subject to further validation in future research.

5. Conclusion

While shifts in organisational cultural are inherently difficult [12], our study points at the significant influence of an innovation friendly culture in terms of support from the executive board and the exchange of the IT department with the clinicians on successful information logistics in clinical processes. Results should encourage particularly German hospital executives to strategically work towards greater collaboration.

6. Conflict of Interest

The authors declare no competing interests.

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